APPARATUS AND METHOD FOR AUTOMATED INTERCONNECTION AND DISCONNECTION OF DISK DRIVE CARRIER IN A SYSTEM

The following patent applications are currently pending before the U.S. Patent and Trademark Office and are incorporated herein by reference: U.S. Patent Application No. 09/477,547 (Attorney Docket No. TU9-99-064), filed January 4, 2000, entitled, *System and Method for Optically Coupling Component Service Interfaces*; U.S. Patent Application No. 09/477,548 (Attorney Docket No. TU9-99-065), filed January 4, 2000, entitled, *Self-Healing Optical Backplane for Coupling Components*; and U.S. Patent Application No. 09/477,546 (Attorney Docket No. TU9-99-066), filed January 4, 2000, entitled, *System and Method for Distributing Power Between Components Via a Magnetic Coupling.*

BACKGROUND OF THE INVENTION

1. Technical Field:

The present invention relates in general to an improved disk drive handler, and in particular to an improved apparatus and method for automatically interconnecting and disconnecting a disk drive carrier in a library.

2. Description of the Related Art:

Hard disk drives (HDD) that are removable during operation in a computer or peripheral systems environment are sometimes referred to as "hot-pluggable." An HDD is typically mounted in a hard disk drive carrier prior to installation in a system. An HDD carrier is a frame-like structure which attaches to the HDD to assist in its insertion into or removal from the system. HDD carriers also protect the HDD when it is outside of the systems environment. HDD carriers are

typically constructed out of metal and/or polymeric materials.

In some types of computer hard disk drive applications, the disk drives are provided in a redundant array of independent disks (RAID) for a storage subsystem. Each drive is loaded in a drive carrier and then mounted in a drawer in the subsystem. A drive carrier typically utilizes a cam mechanism in order to latch itself and the disk drive into a drawer. Unfortunately, the lever that operates the cam must be manually actuated to install or remove the drive carrier from the drawer. Thus, an improved mechanism for installing and removing drive carriers that alleviates the need for manual intervention is needed.

SUMMARY OF THE INVENTION

A disk drive having an optical signal connector and a magnetic power coupling is placed in a drive carrier. The bottom of the carrier has a recess with a transverse pin mounted in the recess. A pair of small magnets are mounted near the rear of the carrier. The carrier slidably mounts in the drawer of a disk drive library. The drawer has an optical signal connector and a magnetic power coupling that mate with those of the disk drive. The drawer also has a sensor for detecting the magnets on the carrier, and an eject button for manually ejecting the carrier. In addition, a drive mechanism is mounted in the bottom of the drawer for engaging the pin on the bottom of the carrier.

Although the carrier may be manually inserted or removed from the drawer, the disk drive library can also perform these functions automatically. The automated sequence is accomplished by inserting the carrier into the drawer until the pin engages the drive mechanism. When the sensor senses the first magnet, the system actuates the drive mechanism to pull the carrier completely into the drawer such that the connectors and couplings interconnect. Proper registration of the carrier in the drawer is verified when the sensor senses the second magnet. The carrier is removed from the drawer by pushing the eject button to reverse the previously described sequence. Alternatively, the system can automatically eject the carrier without human intervention.

The foregoing and other objects and advantages of the present invention will be apparent to those skilled in the art, in view of the following detailed description of the preferred embodiment of the present invention, taken in conjunction with the appended claims and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

So that the manner in which the features, advantages and objects of the invention, as well as others which will become apparent, are attained and can be understood in more detail, more particular description of the invention briefly summarized above may be had by reference to the embodiment thereof which is illustrated in the appended drawings, which drawings form a part of this specification. It is to be noted, however, that the drawings illustrate only a preferred embodiment of the invention and is therefore not to be considered limiting of its scope as the invention may admit to other equally effective embodiments.

Figure 1 is a schematic, bottom isometric view of a disk drive carrier constructed in accordance with the invention.

Figure 2 is a schematic, bottom isometric view of a drawer constructed in accordance with the invention for the disk drive carrier of Figure 1.

Figure 3 is a schematic drawing of a drive mechanism utilized by the drawer of **Figure 2**.

Figure 4 is an operation diagram of the disk drive carrier and drawer of **Figures** 1 and **2**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

EMBODIMENT OF THE PRESENT INVENTION

Referring to **Figure 1**, a tray or carrier **11** for supporting a disk drive **13** in a unitary drive assembly is shown. A Cartesian coordinate system is provided for reference purposes. Drive **13** may be hermetically sealed for protection and portability. Carrier **11** has generally rectangular features, including a top **15**, a bottom **17**, a front **19**, a rear **21**, and sidewalls **23** extending therebetween. In the preferred embodiment, carrier **11** and/or drive **13** has an optical signal connector **25**, and a magnetic power coupling **27** located at or near rear **21**. Connector **25** and coupling **27** are described in greater detail in the co-pending patent applications that are incorporated herein by reference. In addition, bottom **17** is provided with a generally rectangular trough or recess **31** that extends in an x-y plane forward from rear **21**. A pin **33** is transversely mounted in recess **31** such that it extends in a y-direction. A pair of small elements such as magnets **35**, **37** are also mounted to carrier **11**, preferably near rear **21**.

Carrier **11** is designed to be slidably mounted in the slot or receptacle of a drawer **41** (**Figure 2**) of a computer system or disk drive library **43**. Although disk drive library **43** is shown with only one drawer **41**, it is typically provided with a plurality of drawers **41** for a plurality of carriers **11** that may be picked and placed by picking means such as a picking mechanism. Like carrier **11**, drawer **41** has generally rectangular features, including a top **45**, a bottom **47**, a front **49**, a rear **51**, and sidewalls **53** extending therebetween. Drawer **41** has a self-healing optical signal connector **55**, a magnetic power coupling **57**, and an optical, magnetic, or Hall-Effect sensor **59**, all located at or near rear **51**. Connector **55** and coupling **57** are adapted to interconnect with connector **25** and coupling **27**, respectively, while sensor **59** is provided for detecting elements or magnets **35**, **37**, as will be described below. Front **49** has an drive eject button **60** for manually ejecting carrier **11**.

Referring now to **Figures 2** and **3**, bottom **47** of drawer **41** includes a drive means or mechanism **61** that extends in an x-y plane forward from rear **21**. In the preferred embodiment, drive mechanism **61** comprises a motor **63** that drives a worm gear **65**, and a pivotally mounted circular wheel or cam **67** having a peripheral worm gear drive **69** driven by worm gear **65**. Cam **67** moves in the directions shown by arrows **71**, and also has a registration hole **73** for engaging pin **33** on carrier **11**.

In operation (**Figure 4**), disk drive library **43** utilizes a controller **75** for monitoring and controlling the previously described components. Although the drive assembly of carrier **11** may be manually inserted into and interconnected with drawer **41**, and manually removed and disconnected therefrom by depressing eject button **60**, system **43** can also perform these functions automatically in conjunction with the picking means. The automated sequence is accomplished by inserting carrier **11** into the receptacle of drawer **41** only until pin **33** (**Figure 1**) contacts and engages registration hole **73** (**Figure 3**) in drive mechanism **61**. The picking means (or the user, if performed manually) will physically sense this contact. At this point, Hall-Effect sensor **59** senses magnet **35** (**Figure 1**) and signals controller **75**. Controller **75** then actuates motor **63** (**Figure 3**) which drives worm gear **65** to rotate cam **67**. The rotation of cam **67** pulls carrier **11** completely into drawer **41** such that carrier **11** is fully seated in drawer **41**, and power connectors **25**, **55** magnetically couple and signal couplings **27**, **57** interconnect. Proper registration of carrier **11** in drawer **41** is verified by Hall-Effect sensor **59** sensing magnet **37**, which terminates movement of carrier **11** relative to drawer **41**. Disk drive **13** is fully operational in disk drive library **43** at this point.

To disconnect and remove carrier **11** (and, thus, drive **13**) from drawer **41**, the previously described sequence is reversed. Controller **75** is signaled to reverse motor **63** (if done manually, the user pushes eject button **60** to initiate this sequence), which will rotate cam **67** in the opposite direction to push pin **33** and carrier **11** partially out

of drawer **41**. The picking means (or user) may then grasp carrier **11** and fully extract it from drawer **41**.

Alternatively, controller **75** can automatically eject carrier **11** under some circumstances. For example, if drive **13** experiences a disruption in service, is intermittent, or is experiencing other problems, controller **75** can eject carrier **11** and signal an operator or request maintenance.

The present invention has several advantages including a sensor to detect the presence and location of the drive carrier in the drawer. The system has the ability to automatically eject the drive carrier if, for example, there is a disruption in service. The system is also equipped with a push button for manual ejection of the drive carrier. The drawer has a self-healing optical backplane for optical connectors, and power is provided through magnetic coupling. The drives themselves may be hermetically sealed for protection and portability. Finally, single or multi-slot units may be mounted in a library with automated pickers for storage/retrieval of individual drive carriers.

While the invention has been shown or described in only some of its forms, it should be apparent to those skilled in the art that it is not so limited, but is susceptible to various changes without departing from the scope of the invention.